Section 11

ASSESSMENT OF GULF OF ALASKA ATKA MACKEREL

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EXECUTIVE SUMMARY

Relative to the November 2001 SAFE report, the following substantive changes have been made in the current draft of the Atka mackerel chapter:

Changes in the Input Data

1. Catch data are updated.

Changes in the Assessment Methodology

There are no changes in the assessment methodology

Changes in Assessment Results

There are no changes in assessment results

Response to SSC comments

There were no SSC comments pertaining to the Atka mackerel assessment from the December 2001 SSC minutes.

In this assessment the following issues are highlighted:

- Rationale for maintaining separate Bering Sea/Aleutian Islands and Gulf of Alaska Atka mackerel assessments is provided.
- There is no reliable estimate of current biomass from the Gulf of Alaska bottom trawl survey. Using Tier 6 criteria, the overfishing level is set equal to the average catch from 1978-95, which equals 6,200 mt.
- Given that:

  a) there is no reliable estimate of current biomass,

  b) Leslie estimates of local population sizes suggest that abundance had historically declined significantly in localized areas from 1992-94, and

  c) the species has exhibited vulnerability to fishing pressure in the past,

  it is recommended that the ABC for Atka mackerel in the GOA be 600 mt, enough to satisfy only the anticipated bycatch needs of other trawl fisheries, principally those for Pacific cod, rockfish and pollock.

Introduction

Atka mackerel (*Pleurogrammus monopterygius*) are distributed from the east coast of the Kamchatka peninsula, throughout the Komandorskiye and Aleutian Islands, north to the Pribilof Islands in the eastern Bering Sea, and eastward through the Gulf of Alaska to southeast Alaska. Their center of abundance according to past surveys has been in the Aleutian Islands, particularly from Buldir Island to Seguam Pass.

An Atka mackerel population existed in the Gulf of Alaska primarily in the Kodiak, Chirikof, and Shumagin areas, and supported a large foreign fishery through the early 1980s. By the mid-1980s, this fishery, and presumably the population, had all but disappeared. A further indication that the population had disappeared is the bycatch of Atka mackerel in other fisheries was less than 5 mt prior to their inclusion into the Other Species category in 1988. The dramatic decline of the Atka mackerel fishery in the Gulf of Alaska suggests that the area may be the edge of the species' range and be populated only during periods when recruitment, probably as juveniles, from the Aleutian portion of the range is strong (Ronholt 1989). Recently, Atka mackerel have been detected by the summer trawl surveys only in the Shumagin (Western) area of the Gulf of Alaska.

A morphological and meristic study suggested that there may be separate populations in the Gulf of Alaska and the Aleutian Islands (Levada 1979). This study was based on comparisons of samples collected off Kodiak Island in the central Gulf, and the Rat Islands in the Aleutians. Lee (1985) also conducted a morphological study of Atka mackerel from the Bering Sea, Aleutian Islands and Gulf of Alaska. The data showed some differences (although not consistent by area for each characteristic analyzed), suggesting a certain degree of reproductive isolation. However, results from a genetics study comparing Atka mackerel samples from the western Gulf of Alaska with samples from the Eastern, Central, and Western Aleutians showed no evidence of discrete stocks (Lowe et al. 1998). Between-sample variation was extremely low among the four samples indicating a large amount of gene flow is occurring throughout the range. It is presumed that gene flow is occurring during the larval, pelagic stage, particularly in the Aleutian portion of their range, and that the localized aggregations reflect the distribution of surviving, settled larvae and juveniles. Differences in growth rates consistently observed throughout their Alaskan range are believed to be phenotypic characteristics reflecting differences in the local environment.

While genetic information suggests that the Aleutian Island (AI) and Gulf of Alaska (GOA) populations of Atka mackerel could be managed as a unit stock, there are significant differences in population size, distribution, recruitment patterns, and resilience to fishing that suggest otherwise. Bottom trawl surveys and fishery data suggest that the Atka mackerel population in the GOA is smaller and much more patchily distributed than that in the AI, and composed almost entirely of fish > 30 cm in length. There are also more areas of moderate Atka mackerel density in the AI than in the GOA. The lack of small fish in the GOA suggests that Atka mackerel recruit to that region differently than in the AI, perhaps as juveniles moving east from the larger population in the AI rather than from larval settlement in the area. This might also explain the greater sensitivity to fishing depletion in the GOA as shown by both the history of the GOA fishery since the early 1970s and Leslie depletion estimates of catchability (Lowe and Fritz 1996). Catches of Atka mackerel from the GOA peaked in 1975 at about 27,000 mt. Recruitment to the AI population was low from 1980-1985, and catches in the GOA declined to 0 in 1986. Only after a series of large year classes recruited to the AI region in the late 1980s did the population and fishery reestablish in the GOA beginning in the early 1990s. After passage of these year classes through the population, the GOA population, as sampled in the 1999 GOA

bottom trawl survey, has declined and is very patchy in its distribution. Leslie depletion analyses using AI and GOA fishery data suggest that catchability increased from one year to the next in the GOA fished areas, but remained the same in the AI areas. These differences in population resilience, size, distribution, and recruitment argue for separate management of GOA and AI stocks despite their genetic similarities.

Fishery

Catch History and Fishery Management

Prior to the mid-1980s, Atka mackerel were fished exclusively by foreign vessels, primarily from the Soviet Union. Landings peaked at 27,777 mt in 1975, then dropped to almost 0 in 1986. Some joint venture operations participated in this fishery from 1983 to 1985. All landings since then have been taken by the domestic fishery.

In 1988, Atka mackerel were combined in the other species category due to low abundance and the absence of a directed fishery for the previous several years. However, beginning in 1990, Atka mackerel were targeted in the western Gulf of Alaska (GOA). From 1990-1993, catches of other species in the GOA were dominated by Atka mackerel, primarily from the Western regulatory area. Atka mackerel were separated from the other species category and became a separate target category in the GOA in 1994 after approval of Amendment 31 to the Fishery Management Plan for the Groundfish Fishery of the Gulf of Alaska. Recent catches of Atka mackerel from the GOA have been:

Gulf of Alaska (GOA) Catches (mt) by Management Areas

Year	Western	Central	Eastern	Total
1990	1,416	0	0	1,416
1991	3,249	9	0	3,258
1992	13,785	49	0	13,834
1993	4,867	2,143	0	7,010
1994	2,661	877	0	3,538
1995	329	370	2	701
1996	1,577	9	0	1,586
1997	321	8	2	331
1998	279	38	0	317
1999	-	-	-	262
2000	-	-	-	170
2001	-	-	-	66

1 Actual observed catch
2 NMFS Blend data
3 Catches not available by regulatory area; TAC is set GOA-wide.
4 NMFS Bulletin Board as of 10/12/02

Total catches of Atka mackerel were small until 1992, when approximately 14,000 mt were taken in the Shumagin area. The 1990 catch of 1,416 mt is a minimum estimate, since this was the tonnage actually observed by domestic observers. The Regional Office's estimate of catch for 1990 is underestimated, as Gulf of Alaska Atka mackerel catches were incorrectly being reported as landed in the Aleutian Islands (pers. comm. Galen Tromble, Regional Office, Juneau, Alaska). For 1995 and 1996, the Council approved an ABC and a TAC of 3,240 mt for Gulf of Alaska Atka mackerel. For purposes of data collection and effort dispersion, 2,310 mt was allocated to

the Western or Shumagin subarea (Area 610) and 925 mt was allocated to the Central, or the combined Chirikof and Kodiak subareas (Areas 620 and 630). The Western subarea (610) was not opened to the directed Atka mackerel fishery in 1995 because the overfishing level for Pacific ocean perch (POP) was nearly reached; Atka mackerel fisheries have had significant bycatch of POP (A. Smoker, NMFS, Juneau, AK, pers. comm.). In 1996, the fishery in the Western subarea was restricted to a 12-h opening on July 1, due again to concerns about the POP catch exceeding TAC and approaching the overfishing level; about 1,300 mt of Atka mackerel was caught. The 1996 POP catch exceeded the Central area POP overfishing level, thus there was no opening for the Atka mackerel fishery in that area. Since 1997 the Atka mackerel fishery has been managed as a bycatch-only fishery with TACs of 1,000 mt in 1997 and 600 mt for the years 1998 to 2002.

Scientific research catches are reported in the SAFE reports. Table 10.1 documents annual research catches (1977 - 1998) from NMFS trawl surveys.

Description of the Directed Fishery

There has not been a directed fishery for Atka mackerel since 1997. A discussion of the directed fishery for the years 1990-1994 is given in Lowe and Fritz (2001).

Bycatch and Discards

Discussion of the amount of Atka mackerel retained and discarded by target fishery and area in the Gulf of Alaska in 1994 and 1995 have been given in previous assessments (Lowe and Fritz, 2000 and Lowe and Fritz 2001).

Fishery Length Frequencies

Atka mackerel length distributions from the 1990-1994 fisheries are discussed in previous assessments (Lowe and Fritz 2001).

Fishery Sex Ratios

In certain areas and months, historical catches of Atka mackerel were comprised of more females than males (Lowe and Fritz 2001). Differential sex ratios in the historical fisheries could be a result of segregation of the population by sex during spawning and periods of male nest-guarding in summer and early fall. This suggests differential habitat utilization by Atka mackerel in areas frequented by the fishery in the Gulf of Alaska, and has also observed between areas in the Aleutian Islands (Fritz and Lowe 1998).

Fishery Age Frequencies

There is only very limited age data available from the 1990 Davidson Bank fishery, the 1992 Umnak Island fishery and the 1994 fishery which operated off Umnak Island, Davidson Bank and Shumagin Bank. These data are discussed in Lowe and Fritz (2001).

Fishery and Steller Sea Lions

The western stock of Steller sea lions (defined as west of 144°W, or at Cape Suckling east of Prince William Sound) is currently listed as endangered under the Endangered Species Act, and has been listed as threatened since 1990. In 1991-92, 10 nm annual trawl exclusion zones were established around all rookeries west of 150°W; in 1992-93, 20 nm trawl exclusion zones were established around 6 rookeries in the eastern Aleutian Islands that are operational only during the BSAI pollock A-season. In 1993, NMFS designated Steller sea lion critical habitat, which includes a 20 nm aquatic zone around all rookeries and major haulouts west of 144°W, and three

foraging areas, one of which contains Shelikof Strait. Sea lion food habits data collected in the Aleutian Islands revealed that Atka mackerel was the most common food item of adults and juveniles in the summer (NMFS 1995).

From 1977 to 1984 and in 1990, 0-11% of the annual Gulf of Alaska Atka mackerel harvest was caught within 20 miles of all Gulf of Alaska sea lion rookeries and major haulouts, reflecting the offshore distribution of the fishery. In 1991-93, however, the fishery moved closer to shore, and this percentage increased to 82-98%, almost all of which was caught between 10-20 nm of Steller sea lion rookeries on Ogchul and Adugak Islands (near Umnak Island), and Atkins and Chernabura Islands in the Shumagin Islands.

Leslie depletion estimates of local fishery harvest rates were much greater than estimated Gulf-wide harvest rates (Lowe and Fritz 1996; 1997). This could have adversely affected Steller sea lion foraging success, which raised concerns about how the fishery may have affected food availability and the potential for recovery of the Steller sea lion population. There has not been a directed Gulf of Alaska Atka mackerel fishery since 1996. In June 1998, the Council passed a fishery regulatory amendment which proposed a four-year timetable to temporally and spatially disperse and reduce the level of Atka mackerel fishing within Steller sea lion critical habitat in the Bering Sea/Aleutian Islands. The management of the Bering Sea/Aleutian Islands Atka mackerel fishery is detailed in Lowe and Fritz (2000).

Data

Absolute Abundance and Survey Biomass

Bottom trawl surveys of the Gulf of Alaska groundfish community have been conducted every three years since 1984 and biennially since 1999 using an area-depth stratified and area-swept design. In 1999, the same GOA survey design was maintained, but effort allocation was shifted to provide more even coverage within depth strata. Atka mackerel are a very difficult species to survey because: (1) they do not have a swim bladder, making them poor targets for hydroacoustic surveys; (2) they prefer hard, rough and rocky bottom which makes sampling with the standard survey bottom trawl gear difficult; and (3) their schooling behavior and patchy distribution makes the species susceptible to large variances in catches which greatly affect area-swept estimates of biomass.

The general groundfish surveys of the Gulf of Alaska are particularly problematic for Atka mackerel given the characteristics described above. In 1996, a meaningful estimate of biomass could not be determined from the data due to extreme variances. Over 98% of the Atka mackerel caught in the 1996 survey were encountered in a single haul within a large stratum, which yielded a large stratum biomass with an extremely large confidence interval.

Although estimates of abundance from earlier surveys have been presented in previous assessments, they were also compromised by the problem of large confidence intervals, although not to the same degree as observed in 1996. For instance, as in the 1996 survey, 98% of all the Atka mackerel caught in the 1990 survey were captured in one haul. Atka mackerel have been inconsistently caught in the GOA surveys, appearing in 5%, 28%, 12%, 20% and 10% of the hauls in the Shumagin area in the 1990, 1993, 1996, 1999 and 2001 GOA surveys, respectively. Similar to the 1996 survey, virtually all the GOA Atka mackerel biomass from the 2001 survey was encountered in a single haul south of the Islands of Four Mountains. What can be concluded from this is that the general groundfish GOA bottom trawl survey, as it has been designed and used since 1984, does not assess Atka mackerel well and the resulting biomass estimates are not considered reliable indicators of absolute abundance or as indices of trend.

Given the problems with assessing GOA Atka mackerel with the bottom trawl survey, there is no reliable estimate of current biomass of Atka mackerel in the GOA. The only indicator of historical trends in abundance comes from analyses of catch-per-unit-effort of the 1992-94 directed Atka mackerel fisheries south of Umnak Island and southeast of the Shumagin Islands which are detailed in the BSAI assessment (Lowe and Fritz 1997) and in the appendix of the 1996 GOA assessment (Lowe and Fritz 1996). These analyses suggest that the Umnak Island Atka mackerel population declined 81% between 1992 and 1994, while the Shumagin Island population declined 58%.

Survey Length Frequencies

Length frequency distributions from the 1996, 1999, and 2001 surveys are shown in Figure 10.1. Mean lengths of males and females, respectively, from each survey are: 45.4 and 47.0 cm in 1996, 45.4 and 46.8 cm in 1999, and 41.6 and 44.3 cm in 2001.

It is interesting to note that the length frequency distributions of males and females differ in the GOA surveys. The female length frequency distributions show a greater proportion of large fish, while the male distributions show greater proportions of small fish (Figure 10.1). This has not been observed in the Aleutian Islands surveys; the male and female length frequency distributions are not differentiable and survey length frequency distributions are presented for combined sexes (Lowe et al. 2002).

Survey Age Frequencies

Survey age data from the Gulf of Alaska trawl survey are only available from 1993 (Figure 10.11 in Lowe and Fritz 2001). The 1993 survey showed a mode of 5-year olds from the 1988 year class which has also been documented as a strong year class in the Aleutian Islands (Lowe et al. 2002).

Biological Parameters

Natural Mortality, Age of Recruitment, and Maximum Age

A natural mortality rate of 0.3 is assumed for Gulf of Alaska Atka mackerel based on Aleutian Islands Atka mackerel (Lowe et al. 2002).

A qualitative look at the sparse GOA fishery age data shows recruitment patterns similar to the Aleutian Islands fishery. The age of first recruitment appears to be 2 years, and full recruitment at 4 years (Lowe and Fritz 2001). This pattern becomes somewhat obscured when a strong year class dominates the distributions.

The maximum age seen in the Gulf of Alaska fishery is 13 years (1990 fishery). This compares with a maximum age of 15 years for the Aleutian Islands.

Length and Weight at Age

Parameters of the von Bertalanffy length-age equation and a weight-length relationship were calculated from the combined 1990, 1992, and 1994 fishery data. Sexes were combined to provide an adequate sample size. The estimated von Bertalanffy growth parameters are:

L_∞ = 54.56 cm
K = 0.22
t_0 = -2.78 yr

Length-age equation: Length (cm) = $L_\infty\{1-\exp[-K(\text{age}- t_0)]\}$.

The weight-length relationship was determined to be:

Weight (kg) = 4.61E-05*Length (cm) 2.698

Growth parameters were also estimated from data collected during the 1993 Gulf of Alaska survey. As in the Aleutians, the survey tends to select for smaller fish at age than the fishery. The estimated von Bertalanffy parameters from the 1993 survey are:

L_∞ = 47.27 cm
K = 0.610
t_0 = 0.38 yr

and the estimated weight-length relationship is:

Weight (kg) = 1.55E-05*Length (cm) 2.979

Maturity at Length and Age

Female maturity at length and age were determined for Gulf of Alaska Atka mackerel (McDermott and Lowe 1997). The age at 50% maturity is 3.6 years and length at 50% maturity is 38.3 cm (Figure 10.2). The maturity schedules are given in Table 10.2.

Selectivity at Age

The small amount of age data for Gulf of Alaska Atka mackerel show similar selectivity patterns as seen in the Aleutian survey and fishery data. The fishery data tend to show older fish than the survey samples. The oldest age from the 1993 survey was 9 years old and the age distribution consisted of mostly 2-6 year olds (Lowe and Fritz 2001).

Overfishing Level and Acceptable Biological Catch

There is no reliable estimate of current Atka mackerel biomass in the Gulf of Alaska. In this situation, Tier 6 of Amendment 56 of the BSAI FMP defines the overfishing level (OFL) as the average catch from 1978-95, and the ABC cannot exceed 75% of the OFL. The average annual catch from 1978-95 is **6,200 mt, which is the overfishing level.**

The ABC is capped at 6,200 x 0.75 = 4,700 mt. However, we recommend that ABC be set lower than 4,700 mt for the following reasons:

1. When ABCs were lower than 4,700 mt, such as in 1994 when the ABC was 3,280 mt, the fishery may have created localized depletions of Atka mackerel in the two primary fished areas, south of Umnak Island and southeast of the Shumagin Islands (see appendix in Lowe and Fritz 1996). The 1994 ABC was set using a 15% harvest rate applied to the 1993 survey biomass estimate of 21,600 mt. The two 1994 fisheries at Umnak and Shumagin combined for over 3,000 mt of the 3,500 mt caught that year, and harvest rates far exceeded the target 15% in each area: at Umnak, the harvest rate was estimated at 85%, and at Shumagin, the harvest rate was estimated at 91%. The 1990 and 1993 surveys also found that Atka mackerel in the GOA were principally congregated in these two areas used by the fishery. These data indicate that the fishery was very efficient in removing fish from these areas and at rates which far surpassed the target Gulf-wide harvest rate.

2. Analyses of local fishery CPUEs suggests that the Atka mackerel populations at Umnak and Shumagin Islands declined significantly between 1992 and 1994 (see appendix in Lowe and Fritz 1996). This also reflects the trend of the Aleutian Island Atka mackerel population during that period.

3. The GOA Atka mackerel population appears to be particularly vulnerable to fishing pressure because of its very patchy distribution and sporadic recruitment patterns. This is reflected in the Leslie depletion analyses (appendix in Lowe and Fritz 1996) and by the disappearance of the population in the mid-1980s following a period with annual catches as high as 27,000 mt.

For the above reasons, we recommend a 2003 ABC for GOA Atka mackerel sufficient only to satisfy the bycatch needs of other trawl fisheries, a recommendation identical to that made since 1997. Catches of Atka mackerel in the GOA in 1997, 1998, 1999, 2000 and 2001 were only 331, 291, 316, 170, and 76 mt, respectively, which could represent the natural bycatch of Atka mackerel in other groundfish fisheries. **We recommend a 2003 GOA Atka mackerel ABC of 600 mt**, or approximately double the 1997-1999 catches.

Ecosystem Considerations

The Western stock of the Steller sea lion (*Eumetopias jubatus*) has been listed as threatened since 1990 and is currently listed as endangered under the Endangered Species Act. As a result of the listing, trawling was prohibited within 10 nautical miles (nm) of all rookeries in the Central and Western Gulf of Alaska year-round beginning in June 1991; 10 nm no-trawl buffer zones were created around all other Steller sea lion rookeries in the Aleutian Islands and Bering Sea in January 1992. The intent of this action was to exclude trawl fishing activity from areas known to be important for sea lion foraging and reproduction. While there is no proven cause and effect relationship between the decline in Steller sea lion numbers and increases in fishery removals near terrestrial sea lion habitats, NMFS imposed the 10 nm trawl exclusion zones based on general conservation principles in an effort to promote sea lion recovery. Aerial surveys conducted through 1996 revealed that the Steller sea lion population in the western GOA has been relatively stable since 1989, but at about 50% of the size that existed prior to the decline (mid-1970s). This is in contrast to the central GOA, where the sea lion population has declined over 80% in the same period, and continues to decline at about 10% per year (NMFS 1995).

Steller sea lion food habits data (from analysis of scats) from the Aleutian Islands indicates that Atka mackerel is an important part of their diet (NMFS 1995, Sinclair and Zeppelin 2002). The prevalence of Atka mackerel and walleye pollock in sea lion scats reflected the distributions of each fish species in the Aleutian Islands region. The percentage occurrence of Atka mackerel was progressively greater in samples taken in the central and western Aleutian Islands, where most of the Atka mackerel biomass in the Aleutian Islands is located. Conversely, the percentage occurrence of pollock was greatest in the eastern Aleutian Islands. Steller sea lion food habits data from the western Gulf of Alaska are relatively sparse, so it is not known how important Atka mackerel is to sea lions in this area. The close proximity of fishery locations to sea lion rookeries in the western Gulf suggests that Atka mackerel could be a prey item at least during the summer. Analyses of fishery CPUE revealed that the fishery may create temporary localized depletions of Atka mackerel, and that these depletions may last for weeks after the vessels have left the area. This supports the argument already made above in the ABC section for a conservative harvest policy for Atka mackerel in the Gulf of Alaska.

Summary

Tier 6
M = 0.30
F_{ABC}= unknown
F_{OFL}= unknown
2003 exploitable biomass = unknown
2003 Overfishing level = 6,200 mt
2003 ABC = 600 mt

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Table 10.1 Research catches of Atka mackerel from NMFS surveys in the Gulf of Alaska.

Year	Research Catches (mt)
1977	0.3
1978	2.8
1979	0.4
1980	3.8
1981	35.3
1982	27
1983	0.4
1984	7.5
1985	65.7
1986	
1987	6.2
1988	
1989	
1990	2.7
1991	
1992	
1993	2.4
1994	
1995	
1996	15.1
1997	

Table 10.2. Schedules of age and length specific maturity from McDermott and Lowe (1997).

Length (cm)	Proportion mature	Age	Proportion mature
20	0	1	0
21	0	2	0.04
22	0	3	0.22
23	0	4	0.69
24	0	5	0.94
25	0	6	0.99
26	0	7	1
27	0	8	1
28	0	9	1
29	0	10	1
30	0		
31	0.01		
32	0.01		
33	0.02		
34	0.05		
35	0.09		
36	0.17		
37	0.29		
38	0.46		
39	0.63		
40	0.78		
41	0.88		
42	0.93		
43	0.97		
44	0.98		
45	0.99		
46	1		
47	1		
48	1		
49	1		
50	1		

Figures

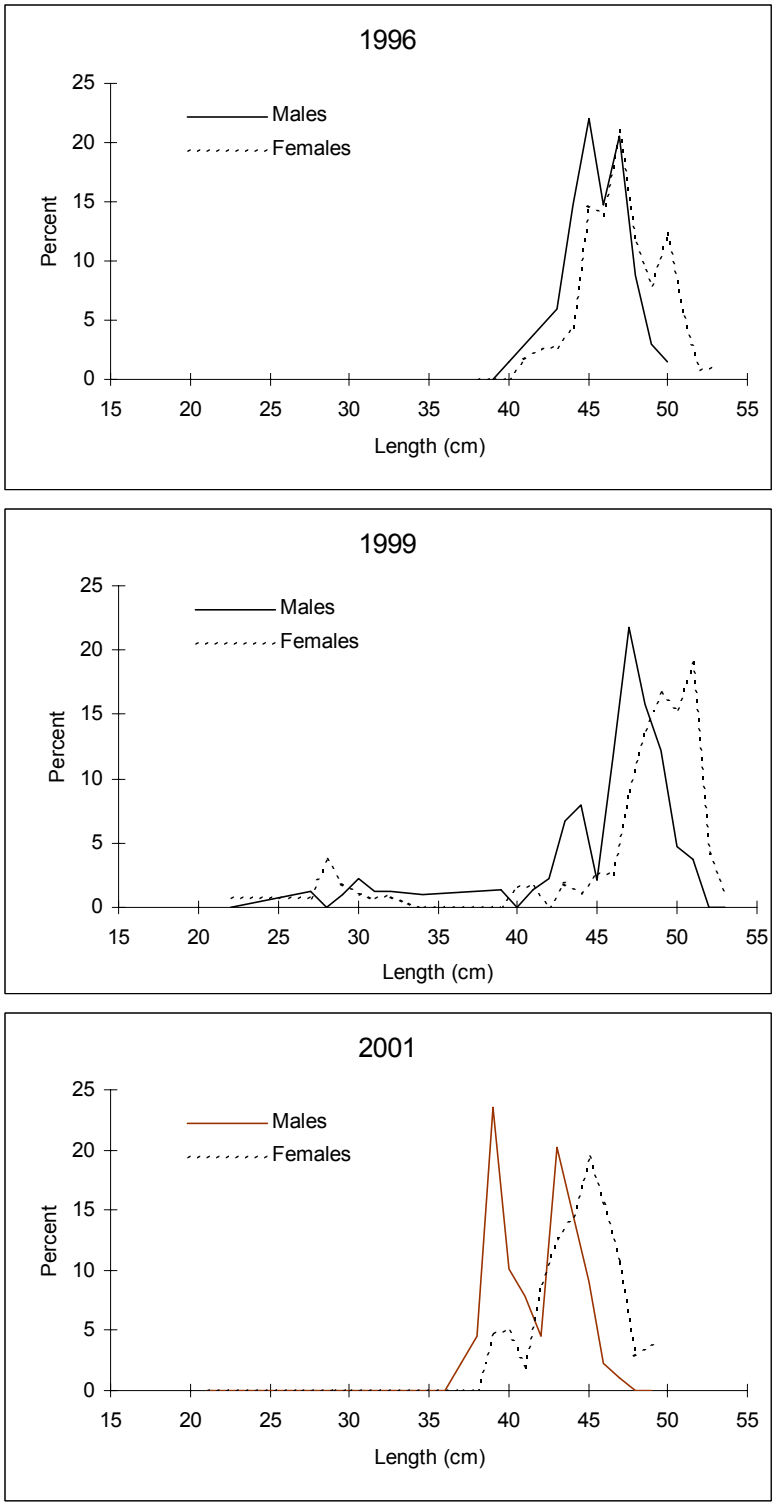

Figure 10.1. Length frequency distributions from the 1996, 1999, and 2001 Gulf of Alaska trawl surveys.

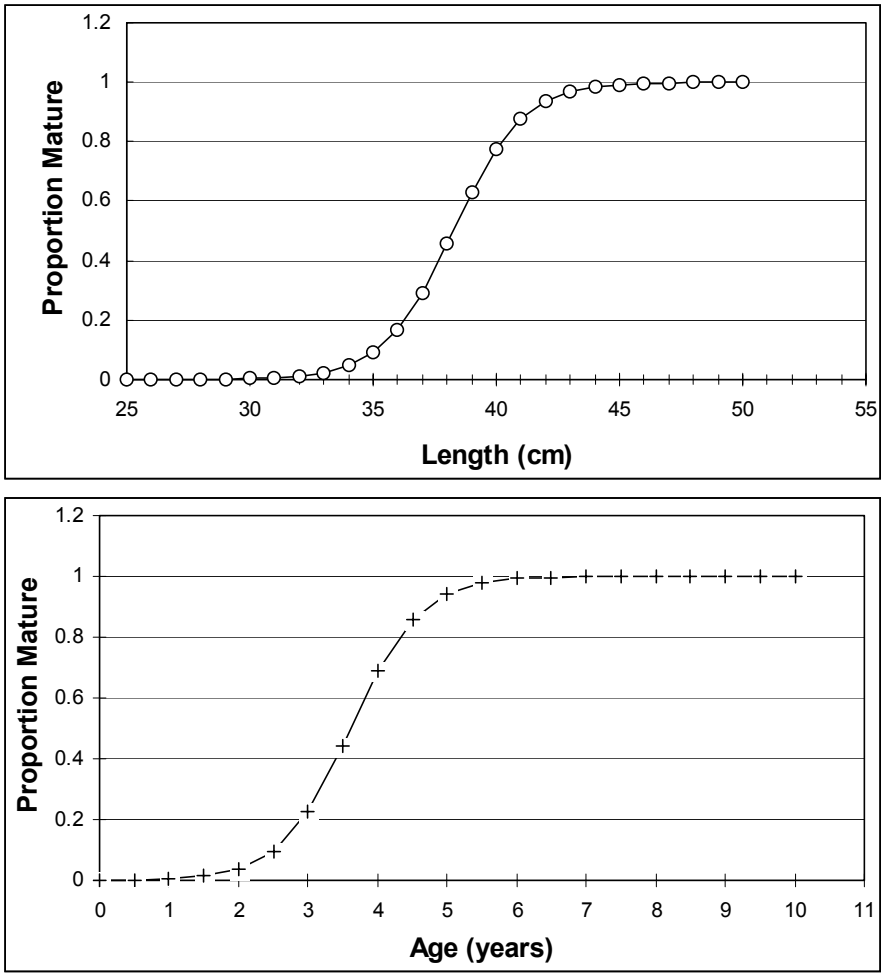

Figure 10.2 Proportion mature at length and age for Gulf of Alaska Atka mackerel.